Report of
Geotechnical Engineering Investigation
Hulman & Idaho Street Floatable Control Structure
Terre Haute, Indiana
Patriot Project No. 02-12-1209

Prepared For:

Mr. Jay Lee
Arcadis
132 E. Washington Street, Suite 600
Indianapolis, IN 46204

Prepared By:

Patriot Engineering and Environmental, Inc.
1359 N. Aberdeen Ave.
Terre Haute, IN 47804

November 5, 2012

November 5, 2012

Mr. Jay Lee
Arcadis
132 E. Washington Street, Suite 600
Indianapolis, IN 46204

RE: Report of
Geotechnical Engineering Investigation
Hulman & Idaho Street Floatable Control Structure
Terre Haute, Indiana
Patriot Project No. 02-12-1209

Dear Jay:

Attached is the report of our subsurface investigation for the proposed floatable control structure and interceptor sewer to be positioned between the existing Idaho St. and Hulman St. sewers adjacent to the Wabash River in Terre Haute, Indiana This investigation was completed in general accordance with our Proposal No. PTH12-069 dated July 18, 2012, with amended fieldwork scope due to obstructions of proposed drilling sites. Authorization to proceed was issued in the form of an agreement received by Patriot on September 19, 2012.

This report includes detailed and graphic logs of the test borings drilled at the proposed project site. Also included in the report are the results of laboratory tests performed on samples obtained from the site, and geotechnical recommendations pertinent to the site development, foundation design, and construction.

We appreciate the opportunity to perform this geotechnical engineering investigation and look forward to working with you during the construction phase of the project. If you have any questions regarding this report or if we may be of any additional assistance regarding any geotechnical aspect of the project, please do not hesitate to contact our office.

Respectfully submitted,
Patriot Engineering and Environmental, Inc.

Timothy C. Govert
Principal

Ronald W. Spivey, P.E.
Senior Project Engineer

RONALD WILLIAM SPIVEY
REGISTERED
No. 9700221
STATE OF
INDIANA
PROFESSIONAL ENGINEER

TABLE OF CONTENTS

REPORT OF GEOTECHNICAL ENGINEERING INVESTIGATION

Hulman & Idaho Street Floatable Control Structure
Terre Haute, Indiana
Patriot Project No. 02-12-1209

1.0 INTRODUCTION

1.1 General

The City of Terre Haute is planning the design and construction of a new floatable control structure and related improvements to the sewer network between Idaho Street and Hulman Street along the bank of the Wabash River. These structures represent a portion of the overall Combined Sewer Overflow (CSO) Improvements being undertaken by the city to serve its wastewater system. Design of this particular project is being conducted by Arcadis for the City of Terre Haute. Patriot Engineering has been contracted by Arcadis to conduct the Geotechnical Investigation for this site. The results of our geotechnical engineering investigation for the project are presented in this report.

1.2 Purpose and Scope

The purpose of this investigation has been to determine the general near surface and subsurface conditions within the project area and to develop the geotechnical engineering recommendations necessary for the design and construction of the new structures and sewer connection for this site. This was achieved by drilling test borings, and by conducting laboratory tests on samples collected from the borings. This report contains the results of our findings, an engineering interpretation of these results with respect to the available project information, and recommendations to aid in the design and construction of the proposed new facilities.

2.0 PROJECT INFORMATION

The project is expected to involve the installation of an interceptor sewer screening structures and floatable control structure to be situated adjacent to the existing sewer lines already installed at the site. The design of these structures is somewhat conceptual at this time. Structure depths are anticipated to be on the order of 15 to 20-feet below the existing surface at the site. We have assumed for the purpose of our analysis that the structures will consist of subgrade facilities with reinforced concrete walls.

3.0 INVESTIGATIONAL PROCEDURES

3.1 Field Work

A total of **three** (**3**) borings were drilled, sampled, and tested at the project site on October 22, 2012, at the approximate locations shown on the Boring Location Map in Appendix A. The initial plan involved drilling a fourth location, however existing trees and debris prevented access to the pre-determined site. This boring, which would have been conducted along the Idaho Street sewer line further inland from the river bank, was cancelled by the client's representative, Amanda Sheehe, in order to meet schedule needs. Additionally, Boring B-1 was moved to the west, nearer the existing interceptor sewer due to obstructions at the initially marked location. This modification to the plan was also approved by Arcadis. The soil borings were drilled to depths of 30-feet along the existing interceptor line between the Idaho and Hulman sewers, and to 25-feet along the Hulman Street line at the site to receive the new interceptor line. All depths are given as feet below the existing ground surface.

The borings were advanced using 3¼" I.D. (inside diameter) hollow-stem augers. Samples were recovered in the undisturbed material below the bottom of the augers using the standard drive sample technique in accordance with ASTM D 1586-74. A 2" O.D. (outside diameter) by $1^{3}/_{8}$" I.D. split-spoon sampler was driven a total of 18-inches with the number of blows of a 140-pound hammer falling 30-inches recorded for each 6-inches of penetration. The sum of blows for the final 12-inches of penetration is the Standard Penetration Test result commonly referred to as the N-value (or blow-count). Split-spoon samples were recovered at 2.5-foot intervals, beginning at a depth of 1-foot below the existing surface grade, extending to a depth of 10-feet, and at 5-foot intervals thereafter to the termination of the boring. Water levels were monitored at each borehole location during drilling and upon completion of the boring.

3.2 Laboratory Testing

Upon completion of the boring program, all of the samples retrieved during drilling were returned to *Patriot*'s soil testing laboratory where they were visually examined and classified. A laboratory-generated log of each boring was prepared based upon the driller's field log, laboratory test results, and our visual examination. Test boring logs and a description of the classification system are included in Appendix A in this report. Indicated on each log are: the primary strata encountered, the depth of each stratum change, the depth of each sample, the Standard Penetration Test results, groundwater conditions, and selected laboratory test data. The laboratory logs were prepared for each boring giving the appropriate sample data and the textural description and classification.

Representative samples recovered in the borings were selected for testing in the laboratory to evaluate their physical properties and engineering characteristics. Laboratory analyses included natural moisture content determinations (ASTM D 2216), and an estimate of the unconfined compressive strength (q_u) of the cohesive soil samples utilizing a calibrated hand penetrometer (q_p). The results of all laboratory tests are summarized in Section 4.2 below and are shown on the boring logs as appropriate.

4.0 SITE AND SUBSURFACE CONDITIONS

4.1 Site Conditions

The project area is situated along the eastern bank of the Wabash River at the near-south side of the City of Terre Haute. Access to the site is afforded via gravel roads through an auto salvage yard located along Prairieton Road. The entire site resides within the river lowland, and contains wetland features including ponds that were holding water at the time of our investigation. Except for the roadways above the existing sewer lines, the site was heavily wooded and also contained appreciable debris, which included vehicles, tires, scrap iron and various other relics, junk and scrap metal. The roadways are also elevated above the surrounding grade, affording cover to the sewers below the roads. It is apparent that the area is predominantly “made-land” as the result of filling to raise the river bank over time. Our experience with other nearby projects along the Wabash River indicates that much of the eastern bank in the city has been filled, typically with uncontrolled, refuse fill.

Some clearing had occurred prior to the fieldwork phase of our investigation, but progress had ceased at the time of drilling. Significant additional clearing and grubbing will be needed prior to installation of the structures associated with this project. Vegetation consist of small scrub to sizable hardwood trees throughout the project area.

The surrounding area is generally comprised of abandoned and defunct industrial sites, a few operational light industrial sites, and light commercial developments. A few multi-family dwellings also exist in the vicinity, but are not prevalent. The site ranges from flat bottomlands to mildly sloped, manmade contours. The overall vicinity generally slopes downward from east to west toward the river. The site topography appears to fall about

15 to 20 feet from the bluff line at the rear portion of the salvage yard to the river to the west. As mentioned previously, the area between the Idaho and Hulman sewers is recessed forming a pond feature. Other ponds and apparent wetlands exist within the lowlands immediately adjacent to the project site as well.

The natural geology at the site is comprised predominantly of alluvial (water placed) soils deposited as the result of glacial meltwater during the Wisconsinan Glacial event. The Wabash River Basin feature is the direct result of this event. Occasional clay, marl and peat deposits can also be found in the river basin feature as the result of the meandering river channel and resultant marsh formations. These normally consolidated soil deposits tend to range in depth from 100 to 150 feet below the surface, depending on the distance from the river channel, and can be generally described as fine to slightly coarser with increased depth. Rock strata beneath the soil profile are typically comprised of sedimentary formations consisting of sandstones and shales, with interbedded limestone and coal layers.

The project site associated with this investigation exists within the downtown area of Terre Haute. As such, it is positioned within a very “mature” zone of development associated with Terre Haute, which began in the early 1800’s. As such, the upper zone of the soil profile has typically been modified, filled or replaced by past development. This particular site exists immediately upon the river bank. It has been our experience that much of the riverbank along the downtown area has been developed by significant filling to raise the grade above the natural contours. The fill often consists of undesirable and unsuitable materials including cinders, trash, rubble and generally uncontrolled fill.

4.2 Subsurface Conditions

Our interpretation of the subsurface conditions is based upon widely spaced soil borings drilled at the approximate locations shown on the Boring Location Map in Appendix A. The following discussion is general; for more specific information, please refer to the boring logs presented in Appendix A. It should be noted that the dashed stratification lines shown on the soil boring logs indicate approximate transitions between soil types. In situ stratification changes could occur gradually or at different depths. All depths discussed below refer to depths below the existing ground surface.

The project site is generally covered with topsoil, which is a surficial blend of silts, sands, and clays, with varying amounts of organic matter. Some portions of the site were covered with sand & gravel aggregate as the result of scraping and dozing activities. The topsoil and cover layer was 3 to 8-inches thick in the borings. It is expected that the organic surfacial layer is thicker in the lowland areas within the project footprint as the result of silting and natural deposition from flooding over time.

The surficial layer is generally underlain by a zone identified as FILL. The FILL materials were typically comprised of loose to very loose CINDERS with varying sand and silty sand components. Standard Penetration Test N-values (blow counts) in the FILL materials typically varied from 3 to 21 blows per foot with an outlier in one interval of 50-blows, which appeared to be attributed to driving the spoon upon a coarse object. The overall average N-value within FILL zone was 12-bpf. The FILL zone was noted to a depth of 12 to 17-feet below the surface.

Below the fill materials, Boring B-1 at the Idaho Street sewer existing interceptor connection encountered loose to medium dense CLAYEY & SILTY SAND, and SAND deposits. These predominantly granular soils exhibited N-values ranging from 6 to 12 bpf, with an average of 9-bpf. The granular soils existed to the boring termination depth of 30-feet in Boring B-1.

Below the fill materials, Borings B-2 and B-3 along the Hulman Street corridor noted the existence of soft to typically medium stiff CLAY and SANDY CLAY. Standard Penetration Test N-Values in these cohesive soils varied from 4 to 10, averaging 7-bpf. Unconfined compressive strength values measured with a hand penetrometer ranged from 0.25 to 0.75 tons per square foot, and moisture contents varied from 30 to 33-percent. The characteristics of these clays indicate that they are likely medium to high plasticity soils. Borings B-2 and B-3 both terminated in these cohesive soils at 30-feet and 25-feet, respectively.

4.3 Groundwater Conditions

During the drilling process, sampling tools were routinely observed to check for the existence of free-water which would indicate groundwater presence. Additionally, the open boreholes were also observed for water above the collapse depth after the removal of the augers upon the completion of each hole. Based on these methods, groundwater was encountered in only Boring B-1, with water indicated on sampling tools during drilling at a depth of 22-ft below the surface. Borings B-2 and B-3 did not indicate water during drilling, and all three (3) of the open boreholes were dry after completion.

The term groundwater pertains to any water that percolates through the soil found on site. This includes any overland flow that permeates through a given depth of soil, perched water, and water that occurs below the "water table", a zone that remains saturated and water-bearing year round.

It should be recognized that fluctuations in the groundwater level should be expected over time due to variations in rainfall and other environmental or physical factors. At this site, the Wabash River stage will obviously have a direct influence on groundwater conditions. The true static groundwater level can only be determined through observations made in cased holes over a long period of time, the installation of which was beyond the scope of this investigation.

4.4 Underground Mining

We have examined statewide maps produced by the Indiana Geological Survey to determine the general proximity and extent of underground coal mines with regard to this site. This review indicates that the site is not underlain by recorded underground mine activity. The nearest know underground workings appear to be approximately 2-miles to the west/northwest of the project site. Attached in Appendix A is a map that was downloaded from the Indiana Geological Survey web site through their Southwestern Indiana GIS Atlas. Please note the disclaimer regarding the accuracy of the data. In addition, it must be realized that abandoned underground mines may exist that are not shown in the Indiana Geological Survey records. Underground mining began in the 1860's but mapping of mines did not begin until the 1930's, therefore about 50% of the underground mines are not mapped. The scope of this study does not include a detailed assessment of subsidence potential due to underground mining.

5.0 DESIGN RECOMMENDATIONS

5.1 Basis

Our recommendations are based on data presented in this report, which include soil borings, laboratory testing and our experience with similar projects. Subsurface variations that may not be indicated by a dispersive exploratory boring program can exist on any site. If such variations or unexpected conditions are encountered during construction, or if the project information is incorrect or changed, we should be informed immediately since the validity of our recommendations may be affected.

5.2 Subsurface Structures

Given the materials and dimensions for the proposed facilities to be installed, it is our opinion that subgrade structures could be considered as floating structures since the weight of the excavated column of soil is expected to exceed the weight of the structure per unit area. It should be recognized, however, that we do NOT recommend placement of the subsurface structures upon any of the unsuitable soils noted in the upper 12 to 17-feet in our borings. Bearing upon the unsuitable FILL materials could result in undesirable settlement. If any of the subsurface structures are expected to bear within the depth of fills, it will be necessary to undercut and replace the unsuitable FILL materials, or a mat foundation could be placed to penetrate below the extent of the FILL materials. Placement of a mud mat is recommended at the base of the excavations to provide a suitable platform for construction activities and to maintain the subgrade quality.

Given the proximity to the Wabash River, the subgrade structure should be designed with an adequate factor of safety against uplift assuming the groundwater level is at ground surface and the station is empty. *Patriot* should be consulted to re-evaluate the bearing equilibrium if the proposed structure is other than reinforced concrete sections, or if the depth or size of the structure are reduced appreciably.

Additionally, any above-grade structures would need to be assessed to determine if additional load beyond the mass of removed soils is being applied. This situation will be dependent upon the actual depth of the subsurface structure, combined with the above grade loads being applied by the building. *Patriot* should be provided with this information once the design is completed. Bearing equilibrium, applied pressures and other considerations can be assessed at that time.

It should be recognized that the near surface soils at this site are NOT suitable to support above grade structures on shallow foundations. Loose, deleterious and generally unsuitable conditions and materials exist to significant depth at this site. Deep foundations, undercutting & replacement or other remediation methods would be necessary to accommodate any structures not bearing upon the subsurface structures discussed at the beginning of this section. Helical piers would also represent a viable option for structures that would need to bear at the current surface elevation.

5.3 Lateral Earth Pressures

The magnitude of the lateral earth pressure is dependent on the method of backfill placement, the type of backfill soil, drainage provisions and whether or not the wall is permitted to yield during and/or after placement of the backfill. When a wall is held rigidly against horizontal movement, the lateral pressure against the wall is greater than the "active" earth pressure that is typically used in the design of free-standing retaining walls. Therefore, rigid walls should be designed for higher "at-rest" pressures (using an at-rest lateral earth pressure coefficient, K_o), while yielding walls can be designed for active pressures (using an active lateral earth pressure coefficient, K_a).

The walls proposed for the project structure are expected to be rigid walls. Therefore, provided **a clean open-graded granular material such as INDOT #8 gravel is used for backfill**, a total soil unit weight (γ_t) of 125 pcf and an at-rest lateral earth pressure coefficient (K_o) of 0.45 can be used for calculating the lateral earth pressures. This would correspond to an equivalent fluid pressure of 57-pounds per square foot (psf) per foot of wall height. This equivalent fluid pressure would increase linearly from zero (0) psf at the ground surface, to its maximum at the base of the wall.

The on-site materials that will be excavated to install the subgrade structures should **NOT** be used as backfill. The appreciable amount of cinders, rubble and fat clays noted in the borings indicate that the soils and materials would not provide desirable characteristics as fill.

Table 5.3: Summary of Lateral Earth Design Pressures:

Material Description	Soil Unit Weight (γ_t) (pcf)	At-Rest Coefficient (K_o)	Active Coefficient (K_a)	Passive Coefficient (K_p)	Coefficient of Friction
Clean, open-graded Granular fill	125	0.45	0.30	3.2	0.55

Given the proximity of the site to the river and its potential for flooding, the hydrostatic pressure due to water build-up against the walls of the diversion structure should be anticipated. In this saturated condition, the equivalent fluid pressure method will be changed for the soil. The lateral earth pressure should be computed using the applicable total soil unit weight above the highest anticipated water level, and a buoyant soil unit weight of 63-pcf below the highest anticipated water level. The earth pressure coefficient indicated above should be used above and below the water level to compute the lateral earth pressure. The hydrostatic pressure should be computed using the highest anticipated water level. The lateral earth pressure and hydrostatic pressure should be added to obtain the total lateral pressure on the wall.

5.4 Seismic Considerations

The site soils include loose, wet and plastic soils which may be susceptible to liquefaction in seismic events. Furthermore, this soil profile is expected to extend to 100-feet or greater at this location. Therefore, it is our professional opinion that these seismic considerations should be appropriately assessed in the design of the structures for this project.

For structural design purposes, we recommend using a Site Classification of **E** as defined by the Indiana Building Code (modified International Building Code). Furthermore, using a Site Classification of **E**, we recommend the use of spectral response acceleration coefficients as follows:

0.2 second period: $\mathbf{S_S}$ = 0.337g and Soil Factor = 2.221
1.0 second period: $\mathbf{S_I}$ = 0.115g and Soil Factor = 3.456

The design spectral response acceleration factors are as follows:

$\mathbf{S_{DS}}$ = 0.499g
$\mathbf{S_{DI=}}$ = 0.265g

The stated seismic values were obtained from the USGS Seismic Hazard Curves and Uniform Hazard Response Spectra v5.0.9a program for seismic design for latitude 39.44816, longitude -87.42424. Other earthquake resistant design parameters should be applied consistent with the minimum requirements of the Indiana Building Code.

5.5 Excavations

The information collected from our boring indicates that the majority of the excavation can be readily accomplished using conventional digging methods. The soils noted to a depth of about 12 to 30-feet below the existing surface may be comprised of very loose to medium dense granular soils. The granular soils, particularly if wet or saturated, will **NOT** hold vertical sides and will slough extensively. Shoring systems will be necessary throughout the depth of excavation to provide side support. Areas that indicate the existence of CLAY soils below about 12 to 17-feet will provide slightly more vertical excavation capability. However, the existence of groundwater with the otherwise softer clays will also prevent using open cuts. Shoring systems will also be required in these soils.

Excavation slopes should be maintained within OSHA requirements. The data collected from our project boring indicates that **OSHA Type C Soils** will likely be encountered throughout the construction excavation depth at this site. The contractor's "*competent person*", as defined by OSHA regulations should assess actual in situ conditions during excavations to determine the necessary shoring and safety requirements. **Furthermore, since this installation is presumed to involve some excavations greater than 20-feet, a protective system must be designed by a registered Professional Engineer**. All other OSHA regulations should also be upheld. In addition, we recommend that any surcharge fill or heavy equipment be kept at least 10-feet away from the edge of the excavation.

5.6 Groundwater

Groundwater was encountered during drilling at the site at only Boring B-1. All other borings were dry during drilling and after completion. However, the adjacent Wabash River will have a direct effect upon the groundwater conditions at this site. In fact, extreme and rapid changes in groundwater should be anticipated during times of excessive precipitation in the area or up stream. The designer should consult river stage records near this site to determine the typical and flood levels in order to design the structures. Furthermore, the constructor must recognize the potential for rapid and extreme changes in groundwater conditions as well as flooding at this site to prepare appropriately for the construction phase. Winter and Spring seasons are typically most prone to higher river stages.

Groundwater inflow into shallow excavations above the groundwater table is expected to be adequately controlled by conventional methods such as gravity drainage and/or pumping from sumps. More significant inflow should be expected in deeper excavations below the groundwater table requiring more aggressive dewatering techniques, such as well or wellpoint systems. It is likely that the more aggressive dewatering efforts will be necessary if construction if performed during wetter seasons and/or when river stage is high.

5.7 Structural Fill and Fill Placement Control

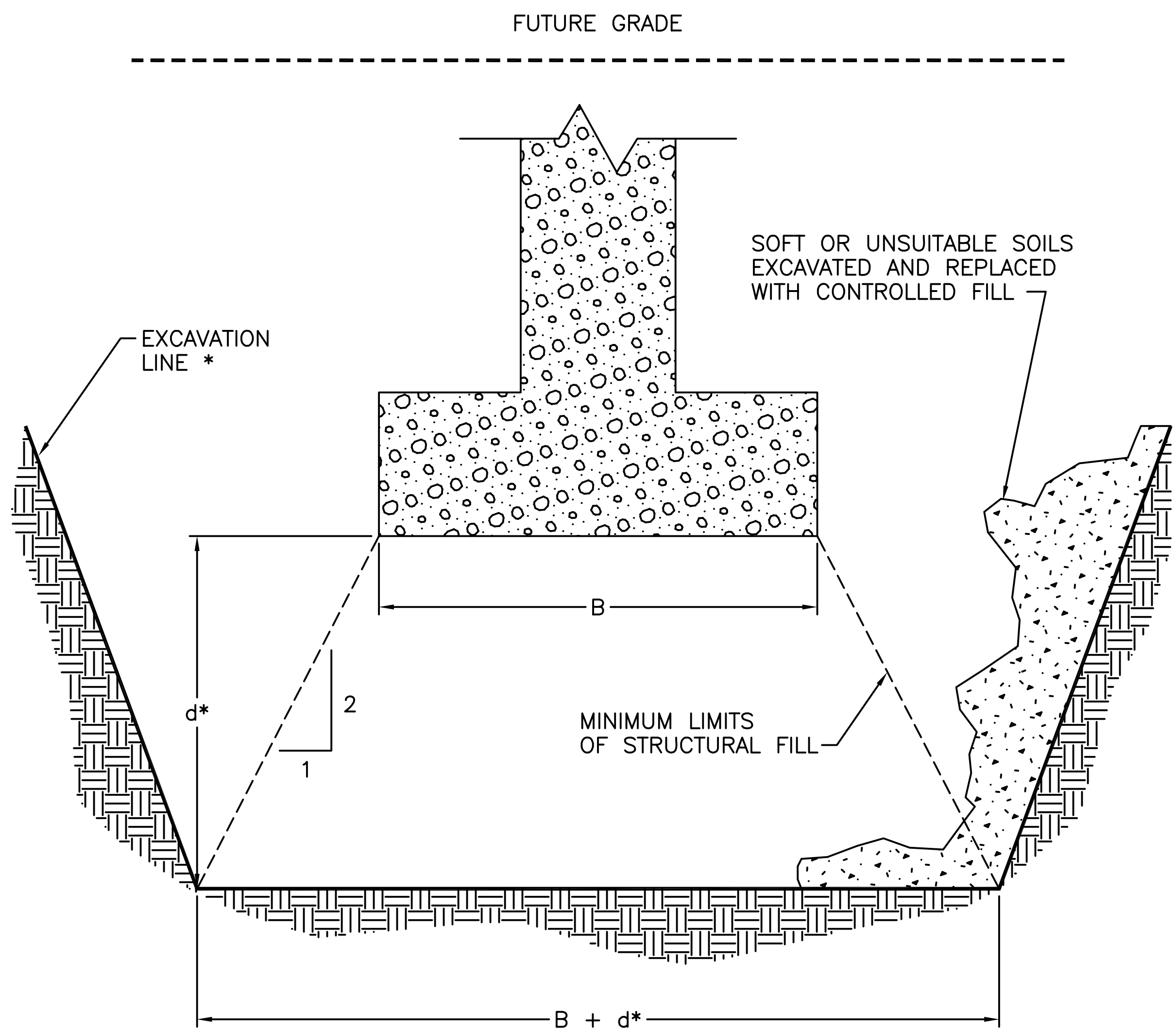
Structural fill, defined as any fill which will support structural loads, should be clean and free of organic material, debris, deleterious materials and frozen soils. Samples of the proposed fill materials should be tested prior to initiating the earthwork and backfilling operations to determine the classification, the natural and optimum moisture contents and maximum dry density and overall suitability as a structural fill.

In general, the on-site soils noted in our borings are **not suitable** for use as structural fill for the project. These materials should be discarded rather than used as backfill. The use of imported granular fill, which is readily available from local borrow sources, is recommended for backfill and fill purposes.

To achieve the recommended compaction of the structural fill, we suggest that the fill be placed and compacted in layers not exceeding eight (8) inches in loose thickness. All fill placement should be monitored by a *Patriot* representative.

Fill placement control and field density (compaction) testing should be conducted by a *Patriot* representative during construction. Fill placement inspection should involve full-time observation of newly placed materials during fill and/or backfill operations to control lift thickness, material quality and compaction effort. Field density testing should be performed in accordance with ASTM D6938, nuclear gauge method, or ASTM 1556, sand-cone method. The frequency of testing should produce a minimum of one (1) density test result per 2,500 square feet, per material-lift, and as necessary to adequately represent the area and compaction effort.

Compaction can be attained through various means of compaction equipment and techniques. In general, sheepsfoot rollers perform more efficiently in cohesive soils, while vibratory smooth drums and plates perform better with granular soils. “Flooding” or “jetting” with water as a means of compaction is generally considered unacceptable.



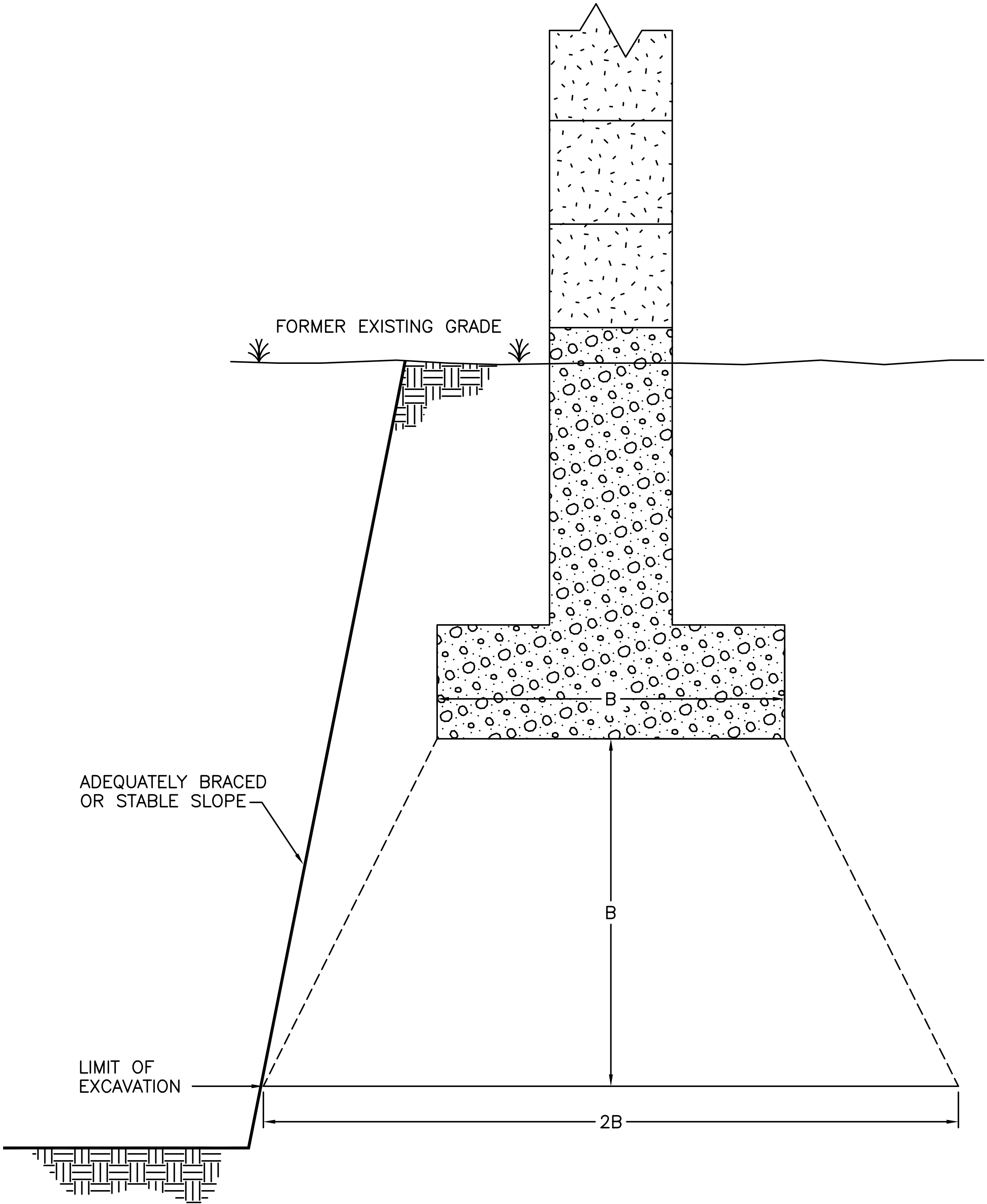
*d IS DEPTH TO SUITABLE SOILS

* IN COMPLIANCE WITH OSHA STANDARDS

PATRIOT ENGINEERING
and ENVIRONMENTAL, INC.
1359 N. Aberdeen Ave. Terre Haute, IN 47804
(812)466.5559 FAX (812)466.5509

Excavation for Footings
In an Area of Fill
ILLUSTRATION A

PROJECT NO.	FIGURE
PAT–UC	1



PATRIOT ENGINEERING
and ENVIRONMENTAL, INC.
1359 N. Aberdeen Ave. Terre Haute, IN 47804
(812)466.5559 FAX (812)466.5509

Excavation Near Existing
In Use Foundations
ILLUSTRATION B

PROJECT NO.	FIGURE
PAT–UC1	1

APPENDIX A

Site Vicinity Map

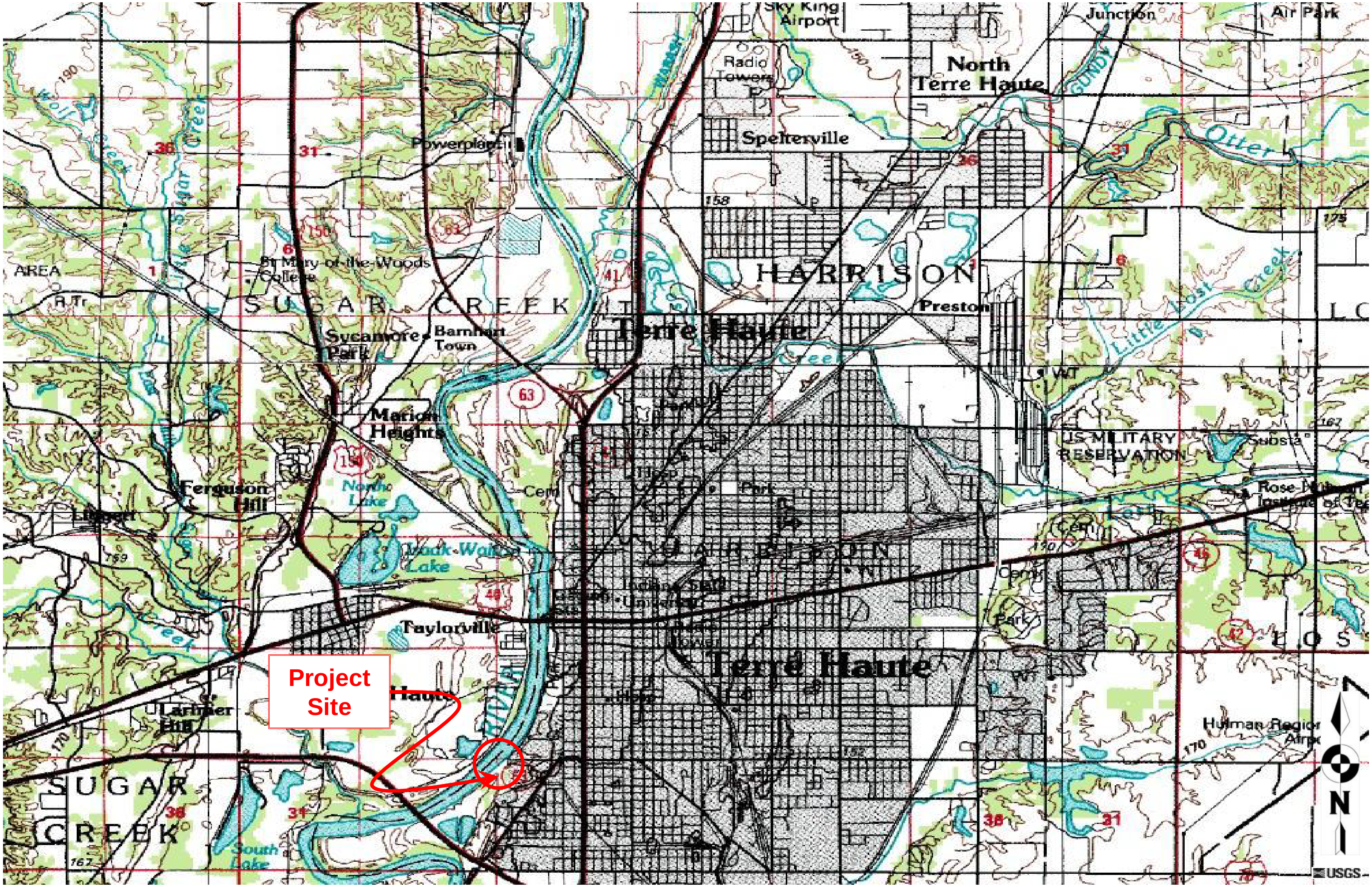
Underground Mine Information

Boring Log Key

Unified Soil Classification

Boring Location Map

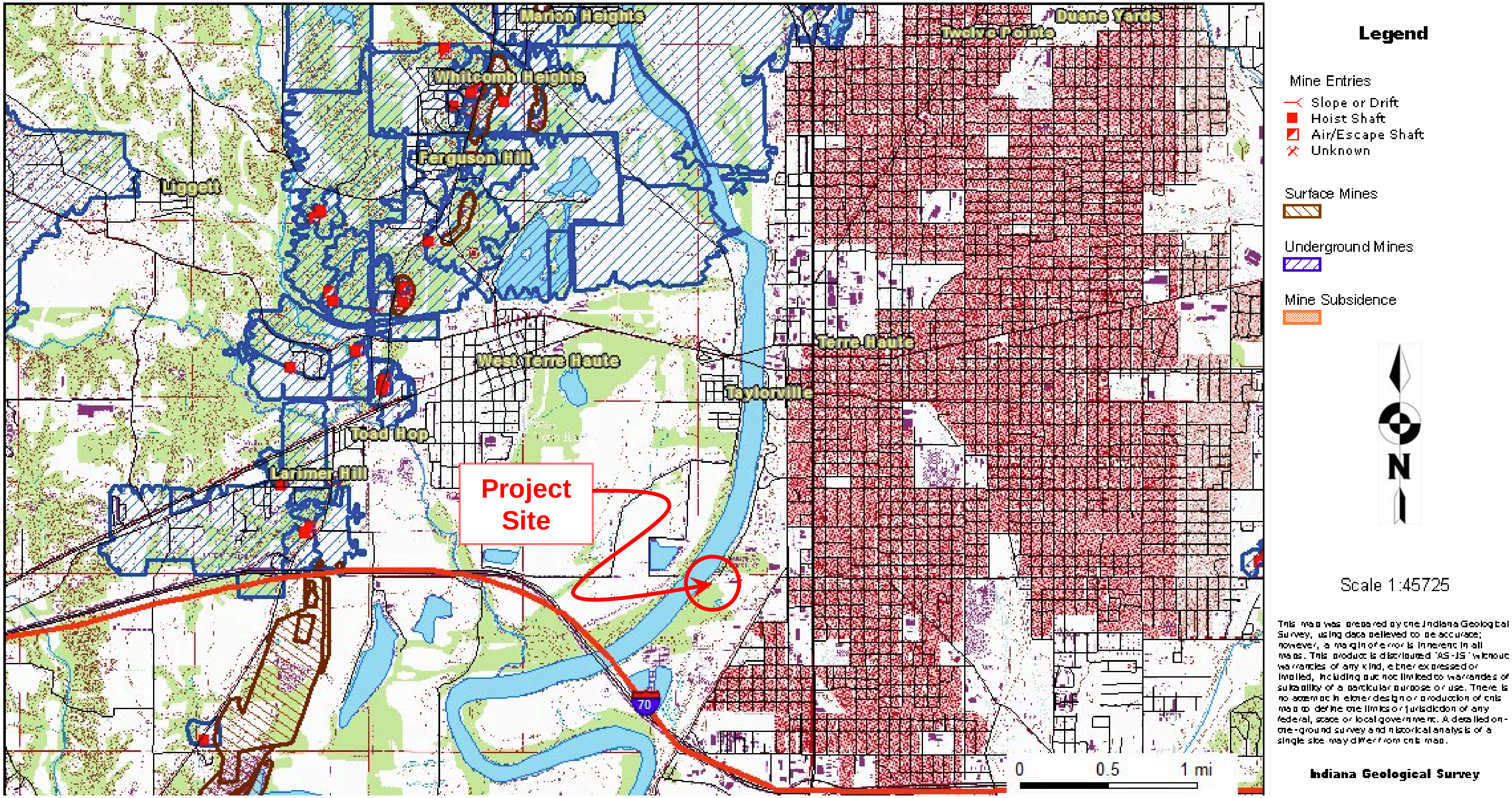
Boring Logs



PATRIOT ENGINEERING
and Environmental, Inc.
Engineering Value for Project Success

Vicinity Map
Hulman & Idaho Floatable Control
Terre Haute, Indiana

Job No.	02-12-1209	**Figure**	1



PATRIOT ENGINEERING and Environmental, Inc.
Engineering Value for Project Success

Underground Mine Map Hulman & Idaho Floatable Control Terre Haute, Indiana	
Job No. 02-12-1209	**Figure** 2

BORING LOG KEY

UNIFIED SOIL CLASSIFICATION SYSTEM
FIELD CLASSIFICATION SYSTEM
FOR SOIL EXPLORATION

NON COHESIVE SOILS
(Silt, Sand, Gravel and Combinations)

Density

Very Loose	-4 blows/ft. or less
Loose	-5 to 10 blows/ft.
Medium Dense	-11 to 30 blows/ft.
Dense	-31 to 50 blows/ft.
Very Dense	-51 blows/ft. or more

Grain Size Terminology

Soil Fraction		Particle Size	US Standard Sieve Size
Boulders		Larger than 12"	Larger than 12"
Cobbles		3" to12"	3" to 12"
Gravel:	Coarse	¾" to 3"	¾" to 3"
	Small	4.76mm to ¾"	#4 to ¾"
Sand:	Coarse	2.00mm to 4.76mm	#10 to #4
	Medium	0.42mm to 2.00mm	#40 to #10
	Fine	0.074mm to 0.42mm	#200 to #40
Silt		0.005mm to 0.074 mm	Smaller than #200
Clay		Smaller than 0.005mm	Smaller than #200

RELATIVE PROPORTIONS FOR SOILS

Descriptive Term	Percent
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

COHESIVE SOILS
(Clay, Silt and Combinations)

Consistency	Unconfined Compressive Strength (tons/sq. ft.)	Field Identification (Approx.) SPT Blows/ft.
Very Soft	Less than 0.25	0 - 2
Soft	0.25 – < 0.5	3 - 4
Medium Stiff	0.5 - < 1.0	5 - 8
Stiff	1.0 - < 2.0	9 -15
Very Stiff	2.0 - < 4.0	16 - 30
Hard	Over 4.0	> 30

Classification on logs are made by visual inspection.

Standard Penetration Test - Driving a 2.0" O.D., $1^{3/8}$" I.D., sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. It is customary for **Patriot** to drive the spoon 6.0 inches to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the tests are recorded for each 6.0 inches of penetration on the drill log (Example - 6/8/9). The standard penetration test results can be obtained by adding the last two figures (i.e. 8 + 9 = 17 blows/ft.).

Strata Changes - In the column "Soil Descriptions" on the drill log the horizontal lines represent strata changes. A solid line (———) represents an actually observed change, a dashed line (- - - - - -) represents an estimated change.

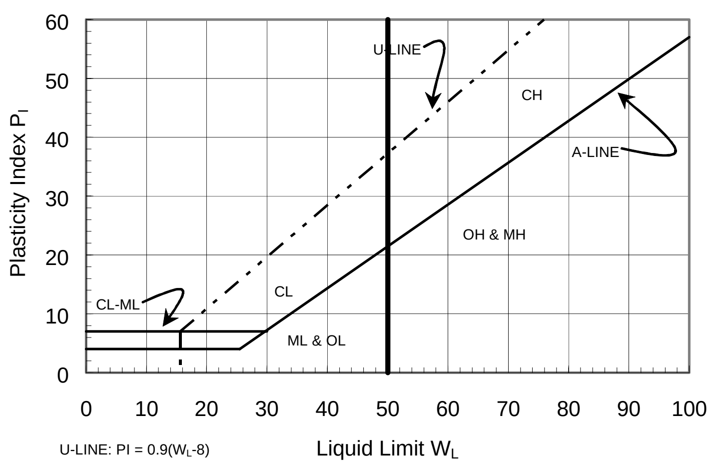
Groundwater observations were made at the times indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water levels indicated on the logs.

Groundwater symbols: ▼-observed groundwater elevation, encountered during drilling; ∇-observed groundwater elevation upon completion of boring.

PATRIOT ENGINEERING
and Environmental, Inc.

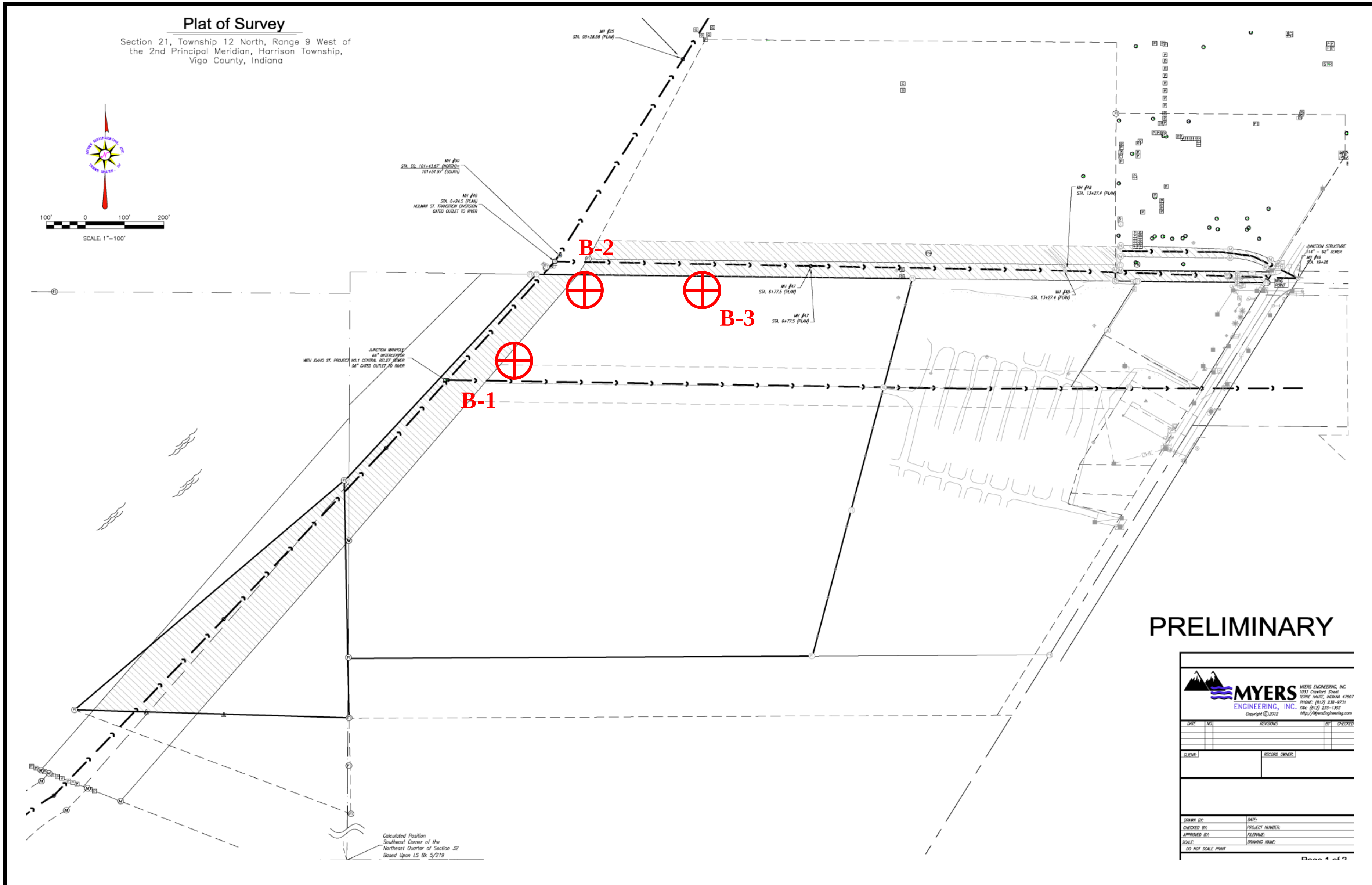
Unified Soil Classification

Major Divisions			Group Symbol	Typical Names	Classification Criteria for Coarse-Grained Soils		
Coarse-grained soils (more than half of material is larger than No. 200)	Gravels (more than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	$C_U \geq 4$ $1 \leq C_C \leq 3$	$C_U = \frac{D_{60}}{D_{10}}$	$C_C = \frac{D^2_{30}}{D_{10}\,D_{60}}$
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting all gradation requirements for GW ($C_U < 4$ or $1 > C_C > 3$)		
		Gravels with fines (appreciable amount of fines)	GM *d*/*u*	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below A line or $P_I < 4$	Above A line with $4 < P_I < 7$ are borderline cases requiring use of dual symbols	
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above A line or $P_I > 7$		
	Sands (more than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines	$C_U \geq 6$ $1 \leq C_C \leq 3$	$C_U = \frac{D_{60}}{D_{10}}$	$C_C = \frac{(D_{30})^2}{D_{10}\,D_{60}}$
			SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW ($C_U < 6$ or $1 > C_c > 3$)		
		Sands with fines (appreciable amount of fines)	SM *d*/*u*	Silty sands, sand-silt mixtures	Atterberg limits below A line or $P_I < 4$	Limits plotting in hatched zone with $4 \leq P_I \leq 7$ are borderline cases requiring use of dual symbols	
			SC	Clayey sands, sand-clay mixtures	Atterberg limits above A line with $P_I > 7$		
Fine-grained soils (more than half of material is smaller than No. 200)	Silt and clays (liquid limit <50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	1. Determine percentages of sand and gravel from grain size curve. 2. Depending on percentages of fines (fraction smaller than 200 sieve size), coarse-grained soils are classified as follows: Less than 5% - GW, GP, SW, SP More than 12% - GM, GC, SM, SC 5-12% - Borderline cases requiring dual symbols		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and clays (liquid limit >50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH	Inorganic clays or high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity, organic silts			
	Highly organic soils		PT	Peat and other highly organic soils			



U-LINE: PI = 0.9(W_L-8)
A-LINE: PI = 0.73(W_L-20)

Plasticity Chart



PATRIOT ENGINEERING and Environmental, Inc.

Engineering Value for Project Success

Boring Location Map
Hulman & Idaho Floatable Control
Terre Haute, Indiana

Job No.	02-12-1209	**Figure**	5

PATRIOT ENGINEERING and Environmental Inc.

Indianapolis, Terre Haute, Evansville, Fort Wayne, Lafayette, Louisville KY, Dayton OH, Nashville TN, Carmi, IL

LOG OF BORING B-1

Hulman-Idaho Floatable Control Structures
Wabash River bank at Hulman St. Interceptor
Terre Haute, Indiana

Client Name	: Hulman-Idaho Floatable Cont. Str.	Driller	: G. Taylor
Project Number	: 02-12-1209	Sampling	: Splitspoon
Logged By	: T. Govert	Weather	: Sunny, 70F
Start Date	: 10/22/12		
Drilling Method	: HSA		

Water Levels
▼ During Drilling: 22-ft.
▽ After Completion: Dry

Depth in Feet	Water Level	USCS	GRAPHIC	DESCRIPTION	Samples	Rec %	SPT Results	qp tsf	w %	REMARKS
0				Topsoil (3")						
0–3				Black, moist, loose, CINDERS	1	56	1/1/5			
3–6		SM		Dark Brown, moist, very loose, SILTY SAND with CINDERS (FILL)	2	56	2/1/2			
6–8		SM		Light Brown, moist, loose, fine SILTY SAND (possible fill)	3	22	4/3/4			
8–13		SM		Dark Brown, slightly moist, loose, SILTY SAND with a little gravel (possible fill)	4	100	5/5/5			Borehole collapsed to 8-feet upon removal of augers.
13–18		SC		Grayish Brown, moist, loose, fine SILTY CLAYEY SAND	5	67	4/5/5			
18–27	▼ (22)	SM		Light Brown, wet, loose to medium dense, fine CLAYEY SILTY SAND	6	67	3/3/3			
					7	100	4/5/7			
27–30		SW		Light Brown, wet, medium dense, well graded SAND with trace gravel	8	100	6/5/6			
30				Boring terminated at 30-ft.						

PATRIOT ENGINEERING and Environmental Inc.

Indianapolis, Terre Haute, Evansville, Fort Wayne, Lafayette, Louisville KY, Dayton OH, Nashville TN, Carmi, IL

LOG OF BORING B-2

Hulman-Idaho Floatable Control Structures
Wabash River bank at Hulman St. Interceptor
Terre Haute, Indiana

Client Name	: Hulman-Idaho Floatable Cont. Str.	Driller	: G. Taylor
Project Number	: 02-12-1209	Sampling	: Splitspoon
Logged By	: T. Govert	Weather	: Sunny, 70F
Start Date	: 10/22/12		
Drilling Method	: HSA		

Water Levels
- During Drilling: Dry
- After Completion: Dry

Depth in Feet	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	qp tsf	w %	REMARKS
0			Topsoil (4")						
0.3–12			Black, moist, loose to very dense CINDERS (FILL)	1	56	7/7/6			
				2	67	4/5/5			
				3	28	50-5"			
				4	0	12/12/9			Splitspoon driven twice; no recovery either attempt.
12–17		SM	Dark Brown, moist, loose, fine SAND with trace CINDERS (FILL)	5	17	8/5/5			Borehole collapsed to 14-feet upon removal of augers.
17–22		CH	Dark Gray, very moist, soft CLAY	6	100	2/2/3	0.25	32	
22–28		CH	Gray with dark gray mottling, moist, medium stiff CLAY with trace fine sand	7	100	3/3/3	0.50	32	
28–30		CH	Gray, very moist, medium stiff SANDY CLAY	8	44	4/5/5	0.50		*Extremely strong petroleum odor evident in Sample #8.
30			Boring terminated at 30-ft.						

PATRIOT ENGINEERING and Environmental Inc.

Indianapolis, Terre Haute, Evansville, Fort Wayne, Lafayette, Louisville KY, Dayton OH, Nashville TN, Carmi, IL

LOG OF BORING B-3

Hulman-Idaho Floatable Control Structures
Wabash River bank at Hulman St. Interceptor
Terre Haute, Indiana

Client Name	: Hulman-Idaho Floatable Cont. Str.	Driller	: G. Taylor
Project Number	: 02-12-1209	Sampling	: Splitspoon
Logged By	: T. Govert	Weather	: Sunny, 70F
Start Date	: 10/22/12		
Drilling Method	: HSA		

Water Levels
▼ During Drilling: Dry
▽ After Completion: Dry

Depth in Feet	Water Level	USCS	DESCRIPTION	Samples	Rec %	SPT Results	qp tsf	w %	REMARKS
0			Sand & Gravel cover (8")						
			Dark Brown, moist, medium dense to loose, SILTY SAND and CINDERS (FILL)	1	78	7/6/6			
				2	56	3/3/3			
5			Black, moist, very loose, CINDERS	3	100	2/2/2			
				4	100	2/1/2			
10									Borehole collapsed to 11-feet upon removal of augers.
		CH	Gray, very moist, medium stiff to soft CLAY	5	67	1/2/2	0.50	30	
15									
				6	100	2/3/3	0.75	30	
20									
		CH	Grayish Brown, moist, medium stiff CLAY	7	100	3/3/5	0.75	33	
25			Boring terminated at 25-ft.						
30									

APPENDIX B

General Qualifications

and

Standard Clause for Unanticipated Subsurface Conditions

GENERAL QUALIFICATIONS

of Patriot Engineering's Geotechnical Engineering Investigation

This report has been prepared at the request of our client for his use on this project. Our professional services have been performed, findings obtained, and recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied.

The scope of our services did not include any environmental assessment or investigation for the presence or absence of wetlands, hazardous or toxic materials in the soil, groundwater, or surface water within or beyond the site studied. Any statements in this report or on the test borings logs regarding vegetation types, odors or staining of soils, or other unusual conditions observed are strictly for the information of our client and the owner.

This report may not contain sufficient information for purposes of other parties or other uses. This company is not responsible for the independent conclusions, opinions or recommendations made by others based on the field and laboratory data presented in this report. Should there be any significant differences in structural arrangement, loading or location of the structure, our analysis should be reviewed.

The recommendations provided herein were developed from the information obtained in the test borings, which depict subsurface conditions only at specific locations. The analysis, conclusions, and recommendations contained in our report are based on site conditions as they existed at the time of our exploration. Subsurface conditions at other locations may differ from those occurring at the specific drill sites. The nature and extent of variations between borings may not become evident until the time of construction. If, after performing on-site observations during construction and noting the characteristics of any variation, substantially different subsurface conditions from those encountered during our explorations are observed or appear to be present beneath excavations we must be advised promptly so that we can review these conditions and reconsider our recommendations where necessary.

If there is a substantial lapse of time between the submission of our report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, we urge that our report be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

We urge that Patriot be retained to review those portions of the plans and specifications that pertain to earthwork and foundations to determine whether they are consistent with our recommendations. In addition, we are available to observe construction, particularly the compaction of structural backfill and preparation of the foundations, and such other field observations as may be necessary.

In order to fairly consider changed or unexpected conditions that might arise during construction, we recommend the following verbiage (Standard Clause for Unanticipated Subsurface Conditions) be included in the project contract.

STANDARD CLAUSE FOR UNANTICIPATED SUBSURFACE CONDITIONS

"The owner has had a subsurface exploration performed by a soils consultant, the results of which are contained in the consultant's report. The consultant's report presents his conclusions on the subsurface conditions based on his interpretation of the data obtained in the exploration. The contractor acknowledges that he has reviewed the consultant's report and any addenda thereto, and that his bid for earthwork operations is based on the subsurface conditions as described in that report. It is recognized that a subsurface exploration may not disclose all conditions as they actually exist and further, conditions may change, particularly groundwater conditions, between the time of a subsurface exploration and the time of earthwork operations. In recognition of these facts, this clause is entered in the contract to provide a means of equitable additional compensation for the contractor if adverse unanticipated conditions are encountered and to provide a means of rebate to the owner if the conditions are more favorable than anticipated.

At any time during construction operations that the contractor encounters conditions that are different than those anticipated by the soils consultant's report, he shall immediately (within 24 hours) bring this fact to the owner's attention. If the owner's representative on the construction site observes subsurface conditions which are different than those anticipated by the consultant's report, he shall immediately (within 24 hours) bring this fact to the contractor's attention. Once a fact of unanticipated conditions has been brought to the attention of either the owner or the contractor, and the consultant has concurred, immediate negotiations will be undertaken between the owner and the contractor to arrive at a change in contract price for additional work or reduction in work because of the unanticipated conditions. The contract agrees that the following unit prices would apply for additional or reduced work under the contract. For changed conditions for which unit prices are not provided, the additional work shall be paid for on a time and materials basis."

Another example of a changed conditions clause can be found in paper No. 4035 by Robert F. Borg, published in ASCE Construction Division Journal, No. CO2, September 1964, page 37.